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To: Phil Isenberg, Chair
Delta Vision Blue Ribbon Task Force

From: Michael Healey, Lead Scientist
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Subject: Levee Facing Materials and Delta Ecology

John Kirlin has asked that I advise you on the ecological significance of levee facing materials.

Delta levees were originally constructed from a variety of materials - silts, sands and muds dredged from the river channel; peats and other soils dug from Delta islands; rock, cobble and gravel brought to the construction site. Some of these materials are subject to erosion and have been protected by logs and brush laid on the levee face. Recent upgrading of levees has often involved facing them with rock riprap to reduce erosion while strengthening the levee. The result is a patchwork of levee facing materials.

Does it matter, ecologically, what kind of material is on a levee face? Yes it does. Different kinds of bottom dwelling organisms will be found on and in substrate materials of different types. These bottom dwelling organisms are an important food source for fish and different types of fish often prefer different types of food. The community of bottom organisms is also important in the processing and recycling of plant materials washed downstream in Delta channels. In addition, the fish themselves, particularly those that live close to the bottom or the edge of the channel, often show a preference for different substrate types. So far as I am aware, no detailed study has been made of the relationships between fish species and substrate in the Delta, although a number of studies have linked near shore fish abundance and species composition to the presence of submerged aquatic vegetation (notably the invasive species *Egeria densa*) (e.g., Brown and Michniuk 2007, Nobriga et al. 2005). The Delta has 1100 miles of levees and levee faces represent a dominant Delta habitat. Even if levees are set back in some areas to provide greater floodplain type habitat in the Delta, levees will continue to constitute a significant Delta habitat. A comprehensive assessment of the ecological role of this habitat, and ways to make it contribute most effectively to desired ecosystem functions is overdue. In the absence of such an assessment, I offer the following generalizations:

1. The abundance, biomass and species richness of the bottom dwelling invertebrate community typically increase with substrate size (e.g., Quinn and Hickey 1990 and see figure below from their paper). Although most studies have been done on stream or river reaches where substrate and flow velocity are interrelated, the relationship also seems to hold for human constructed river banks. Levee faces above the water level can also provide important wildlife and bird habitat, particularly if the levee is vegetated.

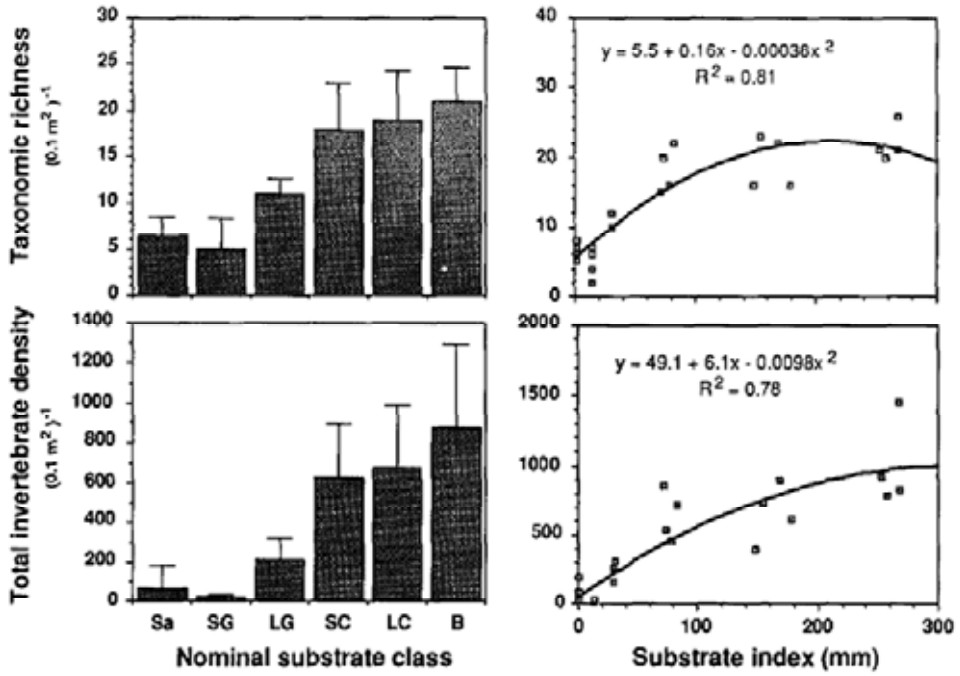

Figure above from Quinn and Hickey showing how species richness and total invertebrate abundance increase with increasing coarseness of the substrate. Substrate classes are in order of increasing size of gravel starting with sand (Sa) and ending with boulders (B). Species richness is in number of species found in 0.1 square meter of substrate and invertebrate density is in numbers of individual organisms found in 0.1 square meter of substrate.

2. Fine substrates tend to be dominated by burrowing invertebrates (such as some midge larvae and oligochaete worms) whereas cobble and boulders are dominated by species that run around on the surface (such as mayfly larvae and caddis fly larvae). Bottom feeding fish are often rather catholic in their feeding preferences but the accessibility and vulnerability of different organisms has a big impact on fish diets.

3. Some bottom living invertebrate species routinely leave the substrate and drift with the current, making them available as food to fishes that do not like to root around on the bottom. The factors that drive invertebrate drift are difficult to pin down and vary among ecosystems but include flow, temperature and turbidity (e.g., Hay et al. 2008). Different substrates with their different species compositions will show different patterns and abundances of drift, affecting their value as a source of fish food.

4. Near shore fishes in the Delta are predominantly alien species (Brown and Michniuk 2007) so that it would be useful to know whether substrate (as well as submerged vegetation) enhances habitat for alien fishes. It should be noted, however, that benthic organisms are also predominantly alien species so that the overall community, fishes and food organisms, is an alien community.

5. Levee facing material is only one of many factors that affect the habitat value of levees, and is probably not the most important. More important are the presence of vegetation on the levees (particularly trees which will shade the near shore and drop leaves and insects into the water, provide nesting and feeding habitat for birds, etc.) and the overall design of the drainage system. Current levee configuration is focused on conveyance, flood control and navigation. The result is an ecologically unfriendly design. Various more eco-friendly designs involving such design features as set back levees, trees (planted in containers if root intrusion into the levee is problematic), and localized floodplain restoration can be found in the ecological engineering literature. The Netherlands, which faces a very similar set of problems to the Delta, including an unsustainable levee system, subsided lands, and loss of ecosystems, has adopted a system of levee set backs, controlled inundation areas, and tidal marsh restoration in the Westerschelde to reduce the risk of floods and improve ecosystem function (Smits et al. 2006).

In conclusion, although levee facing material has potentially important implications for ecosystem function, it should not be considered in isolation. If water supply and ecosystem are to be coequal in the new Delta, the whole design and geometry of the drainage system needs to be examined and redesigned so that ecosystem as well as water supply objectives can be met.

References:

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